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ABSTRACT

For many remote northern communities, especially Native American communities, school design, construction, and heating would be more culturally and technologically appropriate if local materials and expertise were utilized. Following World War II, the period of the most rapid "de-localization" of northern communities, the allegedly uncomfortable log/frame schools were gradually replaced by larger, more modern, structures. The de-localized school's design is not congruent with local cultural configurations. Expensive, physically unsuitable, imported materials are used in construction done by imported laborers. The facility's electrical, heating (dependent on imported fuel), water, and sewer systems are costly to install and maintain. All of these factors lead to the school building being an alien object in the local indigenous community. Students are more likely to have a successful learning experience if the physical school environment reflects a culturally compatible social and physical environment in which the indigenous culture is recognized and built upon. The standardized approach to school design has not allowed for local user participation in planning and design. Log schools provide a physically, technologically, and economically appropriate alternative for northern communities in forested areas that wish to maintain local control. An example of the construction of a rural Alaska high school illustrates conflicts between outside architects and local citizens and the influence of building codes and health and fire safety standards. Examples are given of other alternative construction designs in northern areas that take advantage of local resources and labor. (Contains 15 references.) (SAS)

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THE LOG SCHOOL: A CASE FOR APPROPRIATE DESIGN

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Introduction

For many remote northern communities, especially Native American communities, the design construction and heating of the school would be more culturally and technologically appropriate if local materials and expertise were utilized. In addition there would be widespread beneficial outcomes for the quality of life in the local community.

In the first part of this paper we focus on the continuing de-localization of northern rural communities and how the typical school structure historically has been the paramount manifestation of de-localization. Particular attention is paid to the economic and symbolic significances and consequences of the imported school structure in the rural community. In many ways this external dependency system has had an adverse effect on the creative use of local resources, the subsistence life style and the quality of life itself.

In the second part of the paper we explore how the design, construction and maintenance of the log school could reduce de-localization and contribute significantly to the cultural, economic and technical well-being of the community particularly its educational system. We examine how such topics as appropriate technology, indigenous cultural knowledge, localized energy and resource systems, and self-sufficiency and self-determination are intimately related to the log school concept. We conclude with some suggestions and examples of how more appropriate designs can be developed and utilized to maximize the opportunity for community self-determination and self-reliance and to create an educational environment more appropriately suited to a northern life style.

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Schools In the North

In general the majority of the various developmental processes affecting small northern communities especially Native American communities, or communities established in indigenous Native locales where the majority of the population is Native American, can be seen as a subset of one pervasive historical process —de-localization. Pelto (1975:31), utilizing a general ecological framework, succinctly defines de-localization as:

> . . . the tendency for any territorially defined population to become increasingly dependent on resources, information flow and socioeconomic linkages with systems of energy and resources outside their particular area . . .

and, we might add, outside of their local control. A reality of life in the North, and graphic evidence of the historical consequences of the de-localization process, is the probability that the formerly self-reliant, subsistence-based and autonomous Northern Native American populations would encounter serious survival problems, at least in the short run, without extensive conduits to external resources. While subsistence remains a primary way of life in many northern communities, it is a way of life permeated by external intrusions which have taken on the character of absolute necessities, particularly in the technoeconomic realm, rather than remaining as alternatives. It is very difficult to imagine a northern community, at least in Alaska, devoid of external energy sources, technology, food, clothing, and so forth, because the developmental/de-localization process has affected so many aspects of life and it shows few signs of abating. Nowhere is the de-localization process more vivid than in the incongruities reflected in the physical, psychological, and cultural presence of schools in these communities.

In Alaska, schooling and the attendant construction of school structures were initially part of a religious proselytization effort until the federal government became minimally involved with educating its northern populations through the passage of the First Organic Act of 1884. Schooling then became part of an

ambivalent governmental effort which, at various times, was geared to assimilation, isolationism, self-determination, and segregation —all of which were relatively unsuccessful for reasons too complex to discuss in this paper. Schooling and other governmental services were carried out in school structures typical of the times and setting. Diamond Jenness (1962:29) describes these early structures:

> The frame or log school buildings, whether they contained two classrooms or only one, usually needed repair, lacked running water and indoor facilities, were poorly lighted and, until the early introduction of oil-burning stoves, poorly heated with wood or coal; while the teacher's home, even when detached from the schools, carried only the simplest and cheapest furniture and was hardly more comfortable than the classroom.

While Jenness' description is probably accurate from an external visitor's perspective, it is likely not the perspective of the school structure that would have been elicited from a member of the northern community. From their perspective, the school was and, in most cases, still is the largest and seemingly most modern facility in the community. In the post World War 11 era, the period of the most rapid de-localization of northern communities, the allegedly uncomfortable log/frame schools described by Jenness were gradually replaced by larger and certainly more "modern" structures. These are today being replaced or supplemented by even larger and more technologically advanced structures, so that the school continues to be the most imposing and expensive structure in northern communities. Many would argue that this "bigger and better" aspect of de-localization is as it should be, both in terms of improving education and advancing the quality of life in northern communities. We obviously disagree and advocate the replacement of the large, modern and expensive school structure with more appropriate structures, exemplified by the early log school.

The De-localized School

Today's school structure, the de-localized school, represents a complex of several interrelated characteristics which lead us to advocate its replacement by a more appropriate structure, represented here by the log school.

The de-localized school, because its design is not congruent with the local cultural configurations regarding space and appearance, essentially becomes a huge alien physical island in the community. It is not of the community, and thus seldom becomes part of the community in any meaningful sense. If the de-localized school could be transported intact to Anchorage or Seattle, no one would know that it was not simply a new school that was built there.

In the extreme, the de-localized school is occasionally designed elsewhere with total disregard for both the cultural and physical environment in which it will be situated. One Albuquerque-originated structural design that was constructed in a western Alaskan community had the roof cave in because it was flat rather than pitched —a perfectly appropriate design for the Southwest, but not for the snow-covered North. Another installed the plumbing in the outer wall space, necessitating a complete replumbing after the first freeze-up. As an alien physical presence in the community, the school structure becomes a place where external agents require children to go for certain periods of time, generally to learn alien ways. This compartmentalization likely impinges on the eventual success of the educational activities that occur within the structure, although most current research on the relationship between the physical learning environment and learning processes is at the micro or classroom level rather than at the macro or total school structure level.

The problems created by the de-localized design are exacerbated by the use of non-local or imported materials in the construction of the school. In fact, the de-localized design emanates from the architect/engineer's conversance with the most modern materials available. The metal, fiber glass, glass, plastic and processed lumber are the

sine qua non of the design. Unfortunately, these materials have several drawbacks in the North: they are incredibly expensive because of transportation costs necessary to import them; they often are not suited to the extremes of the northern physical environment; and they create a sensory world that, in conjunction with their spatial arrangement, is usually the antithesis of the child s everyday out-of-school world. These conditions further exacerbate the perceptual distinction between the alien and the normal in the child's and the community's perception. One study described the school s presence in an Alaskan village as follows:

> The total presence of the BIA school—its compound, staff, and technology—provides its educational impact on the village. As observed, the school plant is a model of White perfection which constantly contrasts with the tattered and weatherbeaten Eskimo habitations. Each school has its maintenance workshop and ultramodern diesel light plant that runs continuously. Each school has a kitchen and a multi-purpose room where hot lunches are served or bingo games held for the village on special evenings. The kitchen staff members wear uniforms and waitress-type hats and observe ultrahygienic routines (Collier, 1973:64).

Another important characteristic of the de-localized school is its construction by imported laborers. The rationale for this often revolves around the fact that these individuals are the most familiar with the design, technology and materials being utilized, which are usually external to the community. In most cases, the use of large numbers of imported laborers is unwarranted because there is a large skill inventory among local individuals. However, imported laborers are utilized to construct the imported school; consequently, the de-localized school also becomes a source and symbol of economic discrimination in communities that have few opportunities for wage employment. Whether or not this general process —external design, materials and labor —contributes to the alienation found in many northern communities remains to be answered. We cannot envision how it can be a positive feature in terms of education and/or the quality of life.

A concomitant outcome of the de-localized design is a physical plant whose internal electrical, heating, water and sewer systems are the epitome of a highly complex, de-localized technology. These systems, however, are costly to install because of their sophisticated design and the fact that they must be imported. Secondly, they are extremely difficult and expensive to maintain because they require highly trained technicians and the availability of highly complex component parts, neither of which can be regularly found in the small northern community. For example, many rural Alaskan school districts have had to employ full-time itinerant maintenance personnel just to keep the complex systems functioning. Given the extreme physical environment, it is not uncommon for schools to have serious problems and be without one or more of the complex systems for long periods of time.

An increasingly critical feature of these systems is that they have been designed to be totally dependent on an external energy source —fuel oil. The ubiquitous diesel generator and oil furnace are the mainstays of the de-localized system. Since huge amounts of oil must be imported into the community to operate the systems, the fact that this oil is becoming prohibitively expensive has caused a severe financial drain on many rural school districts in the North. And, for those school districts in Alaska that are purchasing electrical power from the Alaska Village Electrical Cooperative system, the problem is even more severe because of an incredibly high rate structure that reflects the cost of imported oil, the expense of managing and operating a complex statewide system, and the difficulties involved in collecting on expensive services from users in economically depressed areas. Clearly, the de-localized school will only operate if the de-localized ingredients are readily and inexpensively available —a condition that is very uncertain at the present time.

What, then, are the real issues related to this de-localized bigger and better school? First, we argue that the de-localized school is not a culturally appropriate structure in that its design and materials are not compatible with ". . . the sociocultural patterns, goals, values, and circumstances characteristic of the (local) population" (Harding, 1979 4). Secondly, we believe the de-localized school is technologically Inappropriate in that it does not:

> . . . take form at a scale sufficiently small so that an individual could control it, sufficiently simple so that an individual could comprehend it, and sufficiently approachable so that an individual could fix it . . . (Sale, 1980:157).

Third, the de-localized school is simply economically inappropriate and unjustifiable in today's world when viewed from the escalating cost of its design, materials, labor, maintenance and operation. Fourth, the cultural and technological inappropriateness of the de-localized school forms an alien physical and symbolic environment which detracts from, rather than enhances, the educational processes in the local community. In sum, the present de-localized school is contrary to Sale's humanscale technology that "would attempt to adapt itself to the immediate local surroundings, using local materials and energy sources, matching itself to local climates, meshing with local customs and cultures . . ." (Sale, 1980:158).

The Physical Educational Environment

The definition of an educational environment depends on one's methodological and/or theoretical orientation. As we have mentioned, the most common educational environment discussed by researchers is that of the individual classroom. This perspective suggests that there is a need for educators and school architects to explore the design and operation of alternative classroom environments in order to maximize the learning opportunities for children (e.g., Taylor and Vlastos, 1975). The open classroom and learning station approaches are but two examples of alterations of the physical environment of the classroom that provide varied learning opportunities. Others have focused on the total internal spatial configuration of the school structure and have advocated its redesign to maximize learning.

By extending this line of reasoning, one could argue, as we do, that the design of the overall physical environment of the school structure also has a bearing on educational outcomes, particularly in small northern communities where the school starkly contrasts with the local physical and cultural landscape. While there

appears to be little research to support this argument, there are some isolated cases that do seem to address, at least in part, this issue. For example, the design team for a Navajo school/community center attempted to ". . . determine how structures should be built and how space should be structured so as to be both culturally appropriate and preferable to the potential users . . ." so that the structure ". . . will be maximally appropriate and preferred by those who wish to make use of that service or building while at the same time creating the minimum amount of negative reaction against it" (Harding, 1979:4). Such a compatible physical environment becomes all the more necessary as we see an increasing emphasis on more culturally appropriate curriculum content and teaching practices in the schools serving northern Native communities. Again, we can refer to the Navajo experience:

> . . . new educational programs geared to the unique problems of Navajo children are currently being implemented by the Navajo Tribe. Old methods of teaching are being challenged by newer and more responsive methods directly related to this unique cultural group. Any attempt to house these new educational programs in inappropriate facilities is to undermine their value at best, to insure their failure at worst. To plan future schools on the Navajo Nation without implementation of cultural criteria would be irresponsible planning policy. It can be accomplished now —self-determination demands it (Taylor, 1979:54).

Another application of this line of reasoning was the development of the Navajo Community College (now Dine Community College), in which the architects attempted to integrate traditional Navajo design features in the facilities that were built to house the College. Similar considerations have been brought to bear in the design of many other indigenous education institutions, recognizing the educational importance of a culturally congenial environment:

> To the extent that the institutions are able to offer a culturally compatible and congenial social and physical environment in which the indigenous culture is recognized and built upon, the students are that much more likely to find

> the rest of their experience sufficiently comfortable and rewarding to persevere (Barnhardt, 1991).

As we have indicated, we do not feel that the current de-localized, monolithic school is the appropriate or preferred physical educational environment for small northern communities. Thus, we advocate its replacement by an alternative physical educational environment, such as the log school —a human-scale environment that ". . . would enhance the human users rather than alienate them, make them feel good rather than exploited, satisfy rather than frustrate the innate human desire for accomplishment and achievement . . ." (Sale, 1980:157). It is this emphasis on users' needs that underlies our argument, so let us look more carefully at their role in the design process.

User Participation In School Design

Since 1976, when the State of Alaska agreed, in response to a lawsuit, to provide a high school program in any community that desired one, numerous new school facilities have sprung up throughout the rural areas of the state. Though the consent decree agreed to by the State stipulated extensive community participation in the planning and design process, most of the schools were built on a hurried time schedule with little opportunity provided for the serious consideration of realistic alternatives to the conventional monolithic, de-localized school structure. Evidence of the lack of local adaptation in the design process is reflected in the striking similarities in the basic design features of these schools across a wide variety of physical and cultural environments. While this may be convenient for the architects, engineers, builders and administrators, it may also result in some social, economic and educational costs that, in the long run, are unacceptable. As one principal put it at the time the schools were being built:

> Each community wants the best school possible for their children, a very human desire. The architect works with the community to be sure the very top dollar amount allowed by state regulations is reached. Gymnasiums,

> swimming pools, automatic this and futuristic that are designed in, generally without a manual bypass. In a year the automatic does not work or requires special service personnel to be brought in from Anchorage or Fairbanks, occasionally from the South 48. In most cases schools are already pushing the limit of available operational monies. The question is already being asked in many places, where will the money come from to operate these physical plants? (Barnhardt, et al., 1979: 15).

The consequences of this standardized approach to school design has been a constant series of headaches for local school and community personnel over the subsequent 20 years. For example, in one district, ten out of twelve village principals cited maintenance difficulties as the main problem facing them in their new schools. They listed problems such as chopping ice for water because the elaborate water system had frozen where pipes were placed next to exterior walls, hauling sewage in buckets because the disposal system had a mechanical breakdown, and removing snow where it was blowing through cracks and drifting across entrances because the school had been positioned contrary to prevailing wind patterns. These schools were not designed with local conditions in mind.

How then might we better approach the design of new schools, and improve upon the inevitable retrofitting process that has been necessary for the current schools, to help assure more appropriate designs in the future? We can start by paying some attention to the notion of user participation in planning and design processes. Anne Taylor, in working on school design for the Navajo, has indicated that:

> Anglo architects, as long as they are designing for non-Anglos, must develop meaningful methods for user involvement in the design process. Employing participation and criteria from the users in the design process of future schools is urgently needed in order to arrive at school facilities that are more reflective of and responsive to the cultural environment of the Navajo (Taylor, 1979:9).

"User participation" is not simply a matter of conducting a needs assessment, or presenting a prepared plan to a school board for review. It is a much more ambiguous and time-consuming process, and it requires a rethinking of some of the basic assumptions that we carry with us into a design situation. Taylor s perspective on architecture provides an example.

> There is much to learn from architecture before it became an experts art. The untaught builders throughout time demonstrated the ability to construct culturally relevant structures which fit into the natural surroundings. Instead of trying to conquer nature, as western architects in the recent past have done, they worked within, and adapted to, the geographical climate and topography of their surroundings. The buildings also reflected the religion, and worldview of the designers. Unfortunately, yet understandably, most modern architects are ignorant of the life style and social norms of different cultures; trouble results when architects are ascribed an inherent insight into the basic problems of living, regardless of the cultural context. The success of the non-professional design in various cultures, past and present, depends on the harmonious relationship with the social, religious and economic system from which the design and builder are inseparable. This concern of harmony must take priority over the problems of business and prestige if the modern architect is to produce a solution as appropriate to specific cultures as the traditional non-architects have in the past (Taylor, 1979:8).

If users are to be participants in the design process, we must keep in mind the fact that they too have been conditioned to think in certain ways and thus cannot be expected to produce bold, new and innovative designs within a conventional western architectural planning and design framework. They can, however, be recognized as the possessors of useful traditional knowledge, which, when combined with appropriate design processes, can produce locally unique as well as culturally and environmentally adaptive structures. The indigenous Native populations of the North, who have survived in and adapted to the demanding conditions of a harsh climate for centuries, should be recognized as uniquely

knowledgeable in appropriate design and technology for the northern environment (cf. Kawagley, 1995:106). The "longhouses" of the Northwest coast Indians were often architectural and aesthetic marvels of immense size and strength, yet they utilized only those sources of energy and materials that were available from the immediate environment. The Eskimo sod houses required only small amounts of oil, derived as a by-product of the seal hunt, to maintain a comfortable inside temperature, even in the most severe storms. And all of this occurred without the benefit of an architectural or engineering degree, or any formal training in "appropriate technology" or "alternative energy."

If users in northern communities are to be useful contributors to the design of buildings for those communities, we must first learn to appreciate the value of their traditional knowledge, and then we must find ways to tap into that knowledge and incorporate it into the building design and construction process. Only by involving the users in this process, can we expect to reverse the thrust toward de-localization that current approaches foster. One way to increase the level of user participation is to broaden the array of options that a community might consider in the design and construction of a new facility. Exposure to diverse approaches to a design problem and a cooperative analysis of the potential consequences can help both users and professional designers break out of conventional design patterns and remove some of the constraints on innovative thought. At the same time, a close look at the value system and assumptions against which design options are being judged will be necessary to assure that mutually agreed-upon criteria are being utilized. If the professional designer is using one set of standards to judge an option, and the user another, the end result will be satisfactory to no one. If the two are working closely together with a commonly agreed-upon set of assumptions, the end result is more likely to accomplish the purpose for which it is intended.

Where one of the purposes of a design for a given population is to minimize the de-localization processes described earlier, options must be considered that also reduce the local dependence on resources, information flow and socioeconomic linkages with systems of energy and resources outside their particular area (Pelto, 1975:31). By

working together, designers and users can better determine which options will best meet the needs of a particular community and produce a design that minimizes external dependencies and fosters a sense of ownership that allows people to say, "this is our school."

With these views of de-localization and user participation in mind, we turn now to an examination of the log school as an illustration of a culturally, environmentally and economically appropriate design and building process for northern communities.

The Log School: A Localized Alternative

Log construction is a long-standing tradition in the North. Log cabins have been the mainstay of housing construction in many communities and continue to be accorded a prominent place in the mystique of the North, though high costs and uncertain insulating qualities have somewhat reduced their attractiveness in the populated areas where other materials are more readily available. The log school is not a new phenomenon in the North either. Many of the early schools built in the villages of Interior Alaska were of log construction, and some are still in use. The Yukon Territory, Siberia, and the Scandinavian countries are similarly adorned with log school structures. Why then, are so few new schools being constructed of log materials? The experience of one Alaskan community may help us answer that question.

As new high school facilities were being designed for the 126 rural Alaskan villages named in the Tobeluk Consent Decree, architects and school planners were required to solicit the Ideas and concerns of the communities involved. The village of Spruce Creek (a pseudonym) was visited for that purpose by an architect who had been contracted by the regional school district to design the new school for the village. Spruce Creek residents had requested that a high school be built, and they had some definite ideas about what they wanted. The architect arrived on the scene unannounced and requested a meeting with the local Community School

Committee (CSC). He explained his purpose for coming to Spruce Creek and indicated that he needed their approval to proceed with the development of a school design. CSC members expressed their desire to have the school built from local log materials since nearly all of the homes in the community were built of logs by local residents, and they asked that a wood-fired heating system be installed because the village had experienced a shortage of fuel oil in the past, and they did not want to compound the potential problems in the future. They were aware of a similar structure and heating system in a comparable community in the Yukon Territory, and thus knew that their request was feasible.

The architect then proceeded to review the criteria that he was required to adhere to in terms of building codes and health and fire safety standards. He also pointed out the timeline that he would have to meet if the materials were to be ordered in time to be delivered on the spring barge so that full advantage could be taken of the short construction season. Given these constraints, he suggested that the CSC might want to look at some of the prototype designs that he had brought with him and, if they chose a design that fit an existing prototype, he might be able to get them a school by the following year. The CSC members patiently listened to the architect and then pointed out that with a log school the bulk of the structural materials would be local logs that they themselves could gather as a source of employment, thus relieving the pressure to get materials on the spring barge. They remained adamant in their desire for a log design, so the architect reluctantly agreed to consider their views and left with the understanding that he would return with an initial design for their review.

When the architect finally returned, nearly two months later, he brought a design that did reflect some of the floor plan suggestions of the CSC, but the structure was still of standard frame design—not the logs that had been requested. He indicated that it would be difficult to obtain insurance coverage for a log structure and therefore had proceeded on the basis of the prototype he had presented earlier. CSC members indicated that they still wanted to pursue a log design and asked that an

alternative design be presented to them. After the architect left, they checked with an insurance company and found that insurance was indeed available for log structures, although it was slightly more expensive because partial damage to such a structure was more difficult to repair. They conveyed this information to the district office. That was the last they heard of their request until they found out after the next board meeting that the architect s original design had been approved and they would be receiving a standard frame school in their community.

This case illustration presents the de-localization process in action. A community that was trying to establish an appropriate school design that would utilize local resources and labor and reduce the dependency on external energy sources was overridden by the pressures of a system of unaccomodating generalized standards and timelines. The end result was a school that appeared out of context in the village setting, and presented an uninviting atmosphere for community residents. The implicit message of the antiseptic environment was one of preserving the purity and character of the facility, regardless of how alien it was, and thus tended to inhibit attendance and participation in school affairs. Community members had only secondary roles in the construction process, with external labor brought in to install systems that required specialized expertise. An oil-fired heating system was installed which increased the dependency on external energy resources. And the decision-making process pretty well ignored the wishes of the user population. Spruce Creek once again was a victim of de-localization.

Although Spruce Creek was not successful in its bid to obtain a localized log structure for their school, other communities have had some success in getting approval for log designs. A government-sponsored housing project in one small community in Alaska incorporated local logs in the construction of twenty new homes, but then utilized a single standard design and lined them up in a row so that a person standing in the living room of one of them could see through all of them. Another community built a log structure to house university programs in the area. A small community in the Yukon Territory insisted, despite government resistance, on replacing the log school that burned down with a similar structure and on

maintaining wood as the primary source of heat. Not only was wood available locally, its use provided ongoing employment for several members of the community. Log schools are a reasonable alternative for many northern communities in forested regions that wish to maintain some measure of control over their own affairs. They offer a physically, technologically and economically appropriate alternative to the de-localized model described earlier. In addition, they provide a more congenial and unobtrusive environment in which education and other community functions can be carried out.

Log schools provide but one example of how the de-localization process can be counteracted and more energy efficient and environmentally appropriate designs provided for northern communities. They make use of locally available materials, thus encouraging the use of local labor skills that are especially adapted to those materials. Maintenance and upkeep is less of a problem since the resources and skills are, again, readily available. User participation in all levels of planning, design, construction and maintenance is enhanced by local familiarity with and interest in the processes involved. Consequently, the sense of external dependency is decreased and the process of de-localization is curtailed. The result is an approach and structure that resonates well with local life processes.

Many communities, particularly in the northern coastal and tundra areas, do not have immediate access to logs, so log structures do not provide a very practical alternative for them unless the logs are imported, which of course negates the purpose. Let us look, therefore, at some variations on the log school concept that might be considered in the pursuit of localized alternatives. Since one of the purposes of this approach is to decrease dependency on external resources, any design feature that conserves energy and incorporates locally appropriate technology contributes to that purpose. We will touch on a few such features here for illustrative purposes.

One of the most important elements in any northern structure is the heating system. Oil is still the basic fuel for most schools in Alaska, but its escalating cost has

caused several communities and districts to begin looking for alternatives. The most readily available alternative is conservation. Some schools are adding arctic entries and replacing windows on north-facing walls with insulated panels to reduce heat loss. Others are diverting the exhaust from the nearby diesel generator into a heat exchanger in the school building and thus reducing the heat bill. Still others are conducting energy audits to determine the most efficient means to utilize available energy. All of these represent attempts to retrofit existing structures to conserve energy that is otherwise wasted.

Consideration might also be given, in the design of new structures, to incorporating variations on the Eskimo sod house. New techniques for earth-sheltered structures have been developed, such that locations with a favorable topography could build a school partially underground or into a hillside and make use of the natural protection of the earth. This would reduce the amount of wall space exposed to the elements and thus reduce the energy demand. Earth can also be used inside the school in the form of plant beds, which can double as heat sinks and as teaching opportunities. This return to earth materials for construction purposes has been gaining attention in the Southwest United States as well, where the efficacy of adobe —one of the oldest building materials in existence —is being reconsidered for construction purposes.

Wood is another cheap and readily available alternative to fuel oil in many northern communities. Even if local timber is not of sufficient size and quality to be used for building logs, it can still be used for heating. Techniques available for using wood for heat range all the way from the ubiquitous barrel stove to elaborate dual, oil-and wood-fired boiler systems. With the latter, wood can be used to heat just about any building size or configuration. One village in northern Alaska has experimented with heating the school by converting poor-quality wood into chips for more efficient burning. Wood heat goes especially well with log structures because the mass of the logs stores heat and helps maintain even temperatures when the fire burns low. With proper concern for emissions control and safety in

the design and installation process, wood (as well as coal) can serve as a ready replacement for, or supplement to, fuel oil.

The second most critical energy medium in the school is electricity, which again is derived primarily from fuel oil through the use of diesel generators. While reduction in consumption through energy-conserving measures is the easiest step that can be taken to reduce dependency, other generating alternatives are also available, depending on the location. Coastal areas with an ample supply of wind can supplement their supply through the use of wind generators. This energy source is already being used to power National Guard armories in several locations, and new, more efficient designs are being tested. One village in the interior of Alaska is testing the use of a wood-gasification system to generate electricity. Small-scale hydropower has been in use in some communities for many years. The technologies are available but further consideration needs to be given to their application on a more human, community-oriented scale.

Other systems for school structures in a northern environment that call for special consideration are those used for water and sewage disposal. Water systems should be built to match supply and use, and should be designed to minimize maintenance difficulty, taking into account the worst possible conditions. Water storage tanks can be incorporated in the school structure as heat sinks. Sewage systems can be designed to provide the community with fertilizer or gas through the use of humus toilets or methane plants. Grey water can be used for flushing the toilets. One school district has installed small swimming pools that serve as a part of the fire safety system while at the same time they are used to teach students how to swim. All of the subsystems that make up a school structure should be integrated in a way that they reinforce one another and contribute to a common energy system.

It is not necessary, however, that schools be designed as monolithic structures requiring complex, large-scale systems. In fact, smaller building units that can be dispersed around the community may be more appropriate to a localized design than a single, massive complex. Smaller units would be less obtrusive in the

community environment; their reduced size would pose less fire danger; they could convey a social atmosphere more compatible with that of the home; they could be designed on a scale that would take advantage of local materials and expertise; and they could be more readily adapted for other community functions with out having to maintain a massive complex technological system. In addition to size, the positioning of a building is an important consideration in a localized design for the northern environment, because wind and snow can have a major impact on the ability to maintain the building in a usable manner. It is not uncommon for snow drifts to completely cover the entrances of improperly situated buildings. Again, the best sources of information on these matters are the community members themselves, who have learned to adapt to the local conditions.

Given the tenuous transportation and communication links between northern communities, schools must be built to match the environment and draw as much as possible on locally available materials, expertise, and energy sources. External support systems cannot be relied upon in the northern environment. Communities must be self-reliant and self-sufficient to a much greater degree than communities in a more temperate environment.

We have attempted to show that it is indeed possible to provide culturally and environmentally appropriate structures for schools in a northern environment. We have focused on the log school to illustrate our point, and we have described how a more localized approach to the design, construction, and operation of schools can provide many benefits, not the least of which is a reduction in the dependency of those communities on external resources and expertise. It is our view that all of this will lead to a more productive environment for education and other vital processes in northern communities.

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